Energy Yield Modelling

- Methodology paper submitted to “Solar Energy” journal, entitled “Simulating the energy yield of a bifacial photovoltaic power plant”.
- Focus on holistic modelling of absorbed irradiation
- Module rows can mutually influence each other’s energy yield.
- 3-D simulation of casted shadows
- Ground-reflected irradiation is calculated using the theory of view factors on module string level.
- Shaded module strings do not contribute to electricity generation.
- Consideration of electrical efficiency’s temperature dependency

Case Study Based on Bifacial PV Power Plant “La Hormiga” (2.5MW), San Felipe, Chile

- Capacity: 72 270W bifacial modules in landscape format (4 rows, 6x3 modules in each row), 19.44kWdc in total (capacity reduced in order to save computation time)
- Lifetime: 30 years, interest rate: 2.74%
- Ground reflectivity: 25% (dry grassland)
- Cost categories: modules, inverters, installation’s labour & equipment, operation & maintenance (annual increase by 2%), building land (leasing rate increases by 2% annually) and mounting (depends on installation height)

Results

- Figure 1: Simulated absorbed irradiation, generated electricity, BGae and BGel
- Figure 2: Impact of the view fields’ width (corresponding to the building land’s width) on the annual energy yield.
- Figure 3: Relative difference of selected parameters based on two scenarios: 1. Casted ground shadows do not exist, 2. Casted ground shadows do exist.

Indices: GE: Generated electricity, DHI: Diffuse horizontal irradiation, ur: unreflected, gr: ground-reflected, BGae: Bifacial gain in absorbed irradiation, BGel: bifacial gain in electricity generation, CF: capacity factor

Conclusions

Energy Yield

- Presented methodology determines the composition of absorbed irradiation and the impact of casted ground shadows on total energy yield.
- Increasing the width of building land results in an asymptotical increase of energy yield.
- For validation, the specific electricity generation of 52 days was compared with “La Hormiga” generation data of 2017 → overestimation by the model of 6%.

LCOE

- The PV field’s configuration yielding minimal LCOE does not correspond to the configuration with maximal electricity generation.
- A slight increase of row distance does pay off both economically and energetically, since self-shading is reduced; a further increase does not pay off economically since building land is associated with costs.
- A slight enhancement of building land’s width does pay off economically.